and independently of, the actual series of feelings making up its own individual life." To follow this from the idealist's point of view is quite beyond us. A belief in permanent possibilities of sensation that flow on independently of our feelings is in some danger of being mistaken for realism. Mr. Sully, however, is very sure that the realists are wrong; and as a psychologist he must be able, by aid of his science, to explain their error, just as an astronomer accounts for an eclipse. This is how our realistic philosophers go wrong. Under the influence of a refined sentiment of awe, they see what is not there. Not only does this emotion "lead the mind to anticipate the presence of insoluble mystery where a calmer intellectual vision sees only clear regularity, but it serves to support conceptions of an unknowable where the closest observation and most accurate reasoning fail to detect any signs of such an existence." The superstitious terror of the rustic transforms a white calf into a ghost; the awe of the philosopher sees a ghost where there is no calf.

In a very suggestive essay Mr. Sully handles the difficult subject of "Belief: its Varieties and its Conditions." He finds "the primitive germ of all belief, the earliest discoverable condition that precedes in its influence that of action, in the transition from a sensation to an idea." In thus attempting to understand how the state of mind called belief resembles, differs from, and is related to other states of consciousness, Mr. Sully is, we think, on the right track. He is, however, by no means free from the crude, popular notion, that belief and volition, considered as facts of consciousness, have some special causal connection with the bodily movements. Indeed, he thinks that Prof. Bain "has succeeded most completely in showing the will to be a secondary and composite state of mind, inferable from more rudimentary states," one of these so-called rudimentary states being spontaneous bodily movements, which occurring by "a coincidence purely accidental" along with states of consciousness, these unlike things get somehow stuck together by "an adhesive growth, through which the feeling can afterwards command the movement." We have repeatedly maintained that while on the one hand there are reasons which seem to compel the belief that on his physical side man is a machine whose movements can never escape by a hair's breadth from the inexorable rule of physical law, there is on the other hand no "better ground for the popular opinion that voluntary movements take their rise in feeling and are guided by intellect, than a superficial observer ignorant of the construction of the steam-engine might have for a belief that the movements of a locomotive take their rise in noise and are guided by smoke." * That Prof. Huxley's bold advocacy of this view at the recent meeting of the British Association has not called out more angry criticism is surely a most hopeful sign of the times.

It is with regret that we must now take leave of this collection of essays, which we have read with pleasure and profit; and we hope that our mode of expressing our criticisms will not be misunderstood or supposed to indicate a want of appreciation. To touch on all the points we had marked for observation would more than double the length of this review. Especially do we regret not being able to say a few words about "The Æsthetic Aspects of Character." If Mr. Sully could admit that conduct cannot be beautiful in so far as it involves struggle, mental effort, for example, in so far as it is moral or virtuous on the subjective side, very little would then stand between him and one commanding generalisation.

DOUGLAS A. SPALDING

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Sounding and Sensitive Flames *

II.

ANOTHER example of a highly sensitive flame was recently described to me which seems to show that air-currents flowing through gauze at a proper speed are sensitive without the intervention or simultaneous superaddition of a flame. A special kind of Bunsen burner was made with a spiral mixing tube coiled in an inverted cup, at the centre of which is a small chamber covered with wire-gauze at the foot of a short tube or flame-pipe. The gas is admitted by a single jet passing through a cap of wire-gauze covering the conical opening of the spiral tube, the object of this cap of gauze being to distribute the air in its approach, and to protect the gas-jet from ignition. The gas-flame burns with a small bright green cone, surmounted by a larger envelope of pale reddish flame, and it is intensely hot. The green cone indicates combustion of the most complete explosive mixture of air and coal-gas, and when the burner is properly adjusted it can only burn on the top of the flame-tube, where it finds the additional required supply of oxygen; but it descends to the wire-gauze at the foot of the tube if the air-supply exceeds, or the gas supply falls short of the right proportion. In some of these burners the slightest noise of the kind that commonly affects sensitive flames causes the cone of green flame to retreat into the tube and settle on the wire-gauze at its foot, whence it rises again immediately to the top of the tube, when the sound ceases. The explanation seems to be that the air-current entering the mixing-tube through the outer gauze cap is in a sensitive condition, and that when thrown into disturbance by the external sounds, it is more quickly seized and is drawn into the mixing-tube more rapidly by the gas-jet than when it is flowing over the jet in a tranquil state. The inventor of these burners, Mr. Wallace, assures me that some of them exhibit the most sensitive of sensitive flames, and that he has more than once thought of sending one of them as a most singularly effective illustration of such flames to Prof. Tyndall.

The explanation here given of the sensitiveness of Wallace's Bunsen-flame appears to be in great part correct; but the behaviour of the flame, which by Mr. Wallace's kindness I have seen since the above was written, differs considerably from that described; and some experiments connected with it lead me to modify to some extent the foregoing theory of the origin of sensitiveness in wire-gauze flames, and even, apparently, to except the gauze itself from any considerable share of mechanical action in the process. The gas in this burner is first turned low, until the green cone at the centre nearly disappears, and merges into the outer border of the flame from less effective mixture of air with the gas at a low speed of the jet. The flame is now sensitive to the smallest sound, mounting fully one-half higher at every word, or even syllable of a speaker, and at the stroke of a bell, or other acute sound, reaching about twice its ordinary height. It undergoes at the same time no change in its appearance, showing that the contents of the mixing-tube and chamber are merely urged out of the flame-tube with greater speed by some forward impulse of the jet behind. If the sound is continued, as by constantly ringing a bell, the expanded flame gradually subsides, from the expulsion of all the inferior gas-mixture in the burner, reaches its first stature, and passes into a condition of more concentrated combustion corresponding to a fuller, and therefore more rapid admission of gas to the jet; when the sound ceases, the contracted flame gradually recovers its first size and diffuseness from the same cause, namely, the expulsion of all the well-aërated gas in the burner by an inferior mixture which succeeds it at a slower speed.

---

* NATURE, vol. ix. p. 179: "The Relation of Body and Mind."

* Continued from p. 6.

From the following experiment and considerations I am inclined to attribute the observed action of the disturbed flame almost entirely to direct influence of the sound upon the gas-jet, rather than to its effect upon the current of air passing through the conical cap of gauze that surrounds it. The current through the gauze is so slight that ascending smoke, slowly creeping round it, is not visibly drawn into its meshes. The sensitive action of the flame remains equally perfect when all but a very small aperture of the gauze is closely covered with thin sheet india-rubber. To determine if a naked jet, unsurrounded by wire-gauze, would by itself produce a flame so sensitive, I easily obtained with a Ladd's tapering brass jet a flame of this description. Laying it upon its side with its point inclining downwards, and inserting this into a brass tube about ½ in. wide and 15 in. long, also inclined, the flame at the lower end of this tube, when full gas was used, resembled a Bunsen-flame; but if the gas-supply is lowered, it becomes luminous; and at the lowest point at which it will continue to burn, the slight current in the tube appears to consist only of nearly pure coal-gas, and is of course (a useful point in the manipulation) quite inexplosive. A stamp, a cough, or other deep-pitched sound, as the exclamations Oh! and Ah! caused this flame to emerge from its hiding-place in the end of the tube into which it had retreated, and to rise in a tall tongue of light. It was not sensitive to notes of high pitch, to a hiss, nor to some of the acuter vowel-sounds of the voice, unless very strongly uttered; but a short groan or growl called it forth at once. The lower the speed of a jet the slower, possibly, may be the vibrations required to affect and sensibly to disturb its equilibrium. With a very perfect gas-meter the question might also be decided how much of the large additional gas-volume in the flame which occasionally reached a height of about 2 in., and which could easily be maintained permanently at a height of about 1 in. by continued stamping on a stone floor, is derived from the gas-jet itself, and how much from increased admixture with it of the surrounding air. As the jet is constantly being bent, as it leaves the fixed nozzle, into the shape of a corkscrew, or of some other wave-curve by the air-vibrations, it probably draws more air along with it, in the same way that a coarsely twisted rope in hair rope pumps raises more water than a smooth belt or a perfectly smooth and straight rope would do. Something of this kind, perhaps, may be supposed to take place; and contrary to the opinion which I at first entertained, above, of the cause of the sensitiveness at low gas-pressures of Barry's sensitive wire-gauze flame, it seems more probable that the flurry and depression of the flame produced by external sounds is the result of their action upon the gas-jet below, mixing the gas more thoroughly with air, and giving it explosive properties before it passes through the gauze. The gauze-flame must be regulated by lowering the gas-jet, until the brink of its stability and tendency to collapse and burn noisily on the gauze is nearly reached, in order to make this destruction of its equilibrium by external noises possible; and the explanation thus offered of the sensitiveness of the gauze-flame at lower gas-pressures than those used with other flames depends upon no assumption of mechanical actions of unusual delicacy, or indeed of any peculiar kinds of undulation taking place among the perforations of the gauze.

I have quite recently seen an instrument connected very closely with the acoustical properties of flames burning on wire-gauze, showing how well instrument-makers have appreciated them, and how actively they are engaged in representing them in a convenient form. It resembles Geyer's sounding modification of Barry's sensitive flame so nearly, that but for its having received no such title from the maker, the source of its original invention might scarcely be considered doubtful; but it appears more probable, as will be seen from a description in NATURE (to be shortly again referred to) by Dr. A. K. Irvine (vol. x. p. 273), of Glasgow, of identically the same instrument patented many years ago for a very different purpose, that the designer of this singing tube may also have been guided by a knowledge of that invention. Even allowing for the general knowledge of the acoustical properties of wire-gauze flames that has for a long time existed, the instrument shows signs of originality of design that cannot easily be accounted for without some such consideration. It consists of a brass stand with two sliding brackets, one of which supports, in a split cork, a glass tube tapered above to a point to mix a jet of gas with air. The other arm supports a brass tube five-and-a-half inches high, and about an inch and three-quarters wide, closed at the bottom with a disc of gauze held there against a fixed rim in the tube by a wire ring. The position of the gauze close to the bottom of the tube and that of the tapering gas-jet under it, as well as the dimensions of the tube, are the counter-part of Mr. Geyer's experiments with Barry's sensitive flame, only differing in want of adjustibility of the relative positions of the tube and diaphragm of wire-gauze from his arrangement. The arrangement itself is, however, on the other hand, exactly that which Mr. Irvine patented, as will soon be seen, twelve years ago, for use in a new description of miner's safety lamp. The sound produced, when the flame is lighted on the wire-gauze inside the tube and the jet below it is fixed at a proper height, is, as might be anticipated from its high pitch, answering to the short length of the open tube, an excruciatingly piercing note.

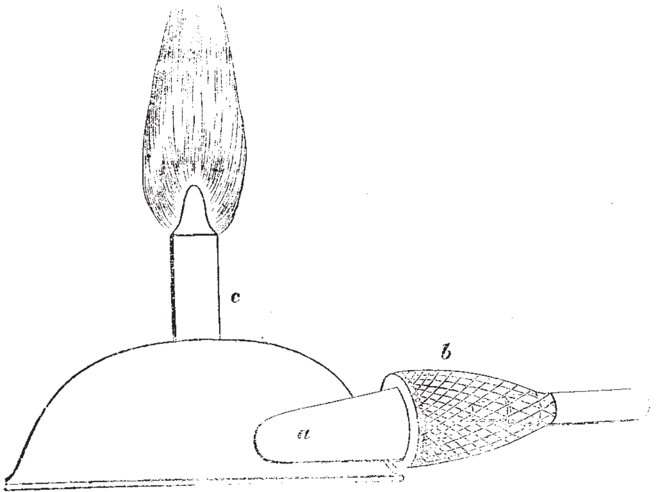
I was not aware that the effect of heat alone in gauze-diaphragms to produce musical sounds in open tubes had been observed and investigated, as it is stated to have been by Prof. Barrett, so thoroughly by Prof. Rijke, of Leyden; and a perusal of that author's description of his experiments, and of his comments upon them, would undoubtedly be of exceeding interest. That the experiment has often been repeated since, and has been varied in many ways by those who were acquainted with it, is a consequence that I was fully prepared to learn, from its great beauty, would follow very speedily upon the first publication of its discovery.

I have never examined sounding and sensitive flames with revolving mirrors; but the result could scarcely fail to prove very instructive. The indications of his own essays in pursuit of this method contained in Prof. Barrett's letter, both where I have been able to consult the original writings and drawings that he quotes, and where he offers us a short account of further results apparently more noticeable than those obtained before, of the appearance of a particularly active and impressionable sensitive flame affected by the vowel sounds, when viewed in a moving mirror, show that the characteristic comportment of these flames is eminently adapted for examination and discussion by such a mode of observation.

Similar experiments on the chirruping, whistling, trumpeting, and other sounding open flames, obtained by the collision of two jets, examined by Prof. Tyndall and Mr. Cottrell, here suggest themselves; but I must hasten to bring this long excursive letter to a close. I cannot, however, do so without expressing my obligation to Prof. Barrett for the valuable references and information that he has been good enough to supply, and for the prompt and ingenuous manner in which he kindly rectified my oblivious association of his name with Mr. Barry's in certain recent observations of the sensitiveness of wire-gauze flames. The notices contained in a short space in his most interesting letter gave me a better acquaintance with the progress of this wide and curious subject, than repeated and anxious inquiries concerning it for several months previously in the scattered pages of many recent scientific journals had enabled me to acquire.

I must also add my acknowledgments to Mr. T. S. Wright and to Mr. A. K. Irvine for the interesting notes that they have furnished in NATURE (vol. x. p. 273, and p. 286) on the early use of wire-gauze flames to produce vociferously loud sounds in open tubes. That large iron tubes specially fitted inside with gauze-covered (or the so-called "smokeless") gas burners, to produce a mighty sound, should be preserved as working instruments of a chemical laboratory in Edinburgh as long ago as the year 1842; and that as much as twelve years since a kind of safety-lamp for mines was patented by Mr. Irvine in this and other countries, sounding a loud alarm note when the lamp-flame lights the explosive mixture of fire-damp entering the bottom of the wick-tube through a wire-gauze disc placed there to cover it, are facts that need no comments to show that the surpassing power of such flames to excite and sustain musical sounds has long been known and used successfully. The excellent character and performance of the instruments used in 1842, as described by Mr. Wright, makes it probable that frequent illustrations of the same kind must already have preceded them. On the other hand, from the well-known scientific eminence of their possessor, Dr. David Boswell Reid, as a skilful director of large works of ventilation, it may also be presumed that they probably presented to his views novelty of some special kind, either of invention or of construction, or of both combined, the result of which was the production of several such superior instruments. It may not be impossible from this consideration, at least if no evidence of considerably earlier origin could be produced, to fix the time, and perhaps the authorship by Dr. Reid himself, or by his brother the chemist, Dr. William Reid of

Edinburgh, in whose laboratory Mr. Wright practised with them, of the first use of smokeless coal-gas flames in acoustical experiments as not long anterior to the date named by Mr. Wright as that of his practical experience of their use. But it must be borne in mind that of all highly inflammable and intensely heating gases next to hydrogen, the most easily procurable since the general extension of the use of coal-gas, is an explosive mixture of the latter gas with air; and the experiments of Sir H. Davy, in 1816, having demonstrated that such a mixture may be prepared safely underneath wire-gauze and may be safely burned above it, the use of the wire-gauze flame for laboratory heating purposes, and also to illustrate very suitably the chemical harmonicon, must have been a very early suggestion. Its unwieldy size and stentorian proportions for the latter purpose, however, have not impossibly led to its comparative abandonment and disappearance from the scene of modern laboratory experiments, and to its general replacement, in coal-gas illustrations of the chemical harmonicon, by various modifications with different forms of jets, of the much more portable, convenient, and easily adaptable Bunsen-burner. Thus a long-recognised and important application of gauze-topped gas-burners in the student's scientific practice might have fallen into oblivion, or into disuse and comparative neglect, if contemporaneous experiments like those of Irvine, Barry, Govi, Geyer, Rijke, and it may safely be prophesied of many other active fellow-workers in the same field of discovery and research, did not revive the discussion, and continue to develop the observation of these flames with multiplied results that appear to be in perfect accordance with the principles, and to furnish the most beautifully effective illustrations possible of important properties of effluent gas-currents, which would perhaps otherwise escape detection. The laws of the flow of escaping gas-jets, their powers of producing ventilation and exhaustion, and, on the other hand, the means of providing for their escape with as little waste of their energy as possible, are questions of practical importance in so many useful industrial applications, that they amply deserve the increased measure of scientific attention which the beautiful succession of modern discoveries of sensitive and sounding flames has been very materially instrumental in attracting, and appears still further to be eminently capable of directing towards them.



J. WALLACE'S TABLE BUNSEN-BURNER.

a.—Conical and spiral mixing-tube coiled inside the foot, terminating at the centre in a small chamber closed with wire-gauze at the top, at the foot of the flame-tube. *b.*—Conical wire-gauze cap, strengthened by three wires to support the gas-tube, to protect the gas from ignition, to keep off draughts, and to distribute the current of air to the gas (*junctions* all soldered). *c.*—Short flame-tube, closed at the bottom with wire-gauze to prevent the flame from flashing back when the gas is turned on or off. Whole height about $2\frac{1}{2}$ in. Height of flame, $1\frac{3}{4}$ in. or 2 in. Height of central bright flame, exactly $\frac{1}{2}$ in.

Newcastle-on-Tyne, Oct. 19 A. S. HERSCHEL

Insects and Colour in Flowers

IN his second letter (NATURE, vol. xi. p. 28) Mr. Mott passes to the discussion of the general question whether beauty is an "object in nature." On that point my feeling is that our knowledge is as yet far too limited for us to presume to declare with any confidence what is an object in nature. Still less should we venture to assert what is *not* an object, and least of all have we any right to affirm that beauty is not an object, when we see developed, beauty of form, of colour, of sculpture and marking, so constantly throughout the organic world, and by such a great variety of means. Sometimes beauty of colour undoubtedly exists when, so far as we can see, it confers no benefit whatever on its possessor. Mr. Darwin instances arterial blood and the autumnal tints of leaves. More frequently it is accompanied by some advantage, direct or indirect; and the question is whether in *such* cases it has been acquired through the operation of sexual or natural selection, more particularly whether in the case of flowers the selection has been effected through the agency of insects, which have favoured the most conspicuously coloured. It remains with Mr. Mott to show in what way the facts detailed in his original letter (I hope he will pardon me for taking him back to it) fail to harmonise with that doctrine. To my mind the fact that a cultivator, by carrying out a like selection, propagating from plants which bear the largest and brightest, double or showy sterile flowers, can produce like results, supports and corroborates the doctrine rather than militates against it. Nor can I see anything discordant in the fact that the colour of fruits has been acquired through the medium of an entirely different selecting agent.

One circumstance appears to me to present some difficulty; and, although it is in no way connected with Mr. Mott's letter, I should like to mention it in the hope that others may be able to supply a satisfactory explanation: it is the case of flowers that are coloured on the outside, but white within. Where such flowers from their position or form present to view principally their exterior, as *Tulipa celsiana*, this is an adaptation that can be readily understood; but some display mostly their interior, and it is then difficult to understand the acquirement of colour outside only. I would instance *Simethis bicolor*, *Gypsophila cretica*, *Daphne jasminea*, and several species of white-rayed Compositæ. *Bellidiastrum michelii*, for example, has frequently the inner surface of the ray florets quite white, and when the flower is open nothing else is seen; the colour on their outer surface only becomes visible when they close over the disc, as in dull and rainy weather. THOMAS COMBER

Newton-le-Willows, Nov. 16

WITH reference to this question, is cross-fertilisation so desirable for the plant as is stated?

In this country, and I believe as a rule elsewhere, brilliant flowers are produced by shrubs, climbing and herbaceous plants, while the inflorescence of trees is comparatively inconspicuous. Does it not seem probable that beauty of colour is gained at the expense of strength, majesty, and longevity? J. S. H.

Droseræ

I FIND that during my absence from England many applications have been made for plants of the Droseræ and Pinguiculæ, and from the replies which have been sent on receipt of the plants they seem to have given satisfaction. Lately, however, in consequence of the weather, there has been some difficulty in obtaining *D. intermedia*, but before this is printed in your columns, all existing applications will be cleared off.

I wish to add, that in winter these plants can scarcely be expected to be as active as in spring and summer, and observers must wait patiently until spring before they may hope to obtain successful results from their observations: it cannot be necessary, I think, to *feed carnivorous plants artificially during the winter;* and a hot-house or conservatory cannot be absolutely necessary, as they have no such advantages in their native wilds.

G. H. HOPKINS

Suicide of Scorpions

THAT scorpions do commit suicide, as described by your correspondent last week, is a well-known fact. My grandfather often related how he had seen these creatures, when surrounded by a circle of glowing embers, make for the inner side of their fiery prison, then deliberately move round the inside of the circle, and when arrived at the exact spot from which they started, turn back their tails and sting themselves to death.

Clyde Wharf, Nov. 16 M. L.